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COURSE: ANA 305

ASSIGNMENT

1. Write an essay on the histological importance of eye in relation to their cellular functions.
2. Corona virus can penetrate the body through the eye and implicate the immune system, briefly discuss the layers of the retina for information penetration.

1.

The eyes are highly developed photosensitive organs for analyzing the form, intensity and colour of light reflected from objects and providing the sense of sight. The eyes are protected within the orbits of the skull which also contain adipose cushions. Internally, the eye contains transparent issues that refract light to focus the image, a layer of photosensitive cells and a system of neurons that collect, process and transmit visual information to the brain.

The internal structures of the eye consist of three layers of tissue arranged concentrically:

1. A tough external fibrous layer(fibrous tunic): This layer forms a capsule enclosing and protecting the other components of the eye. It consists of the **sclera** with primarily structural functions, and the transparent **cornea**, which is part of the optic apparatus.
2. A middle vascular layer(vascular tunic): This layer is also called the uveal tract. It includes the **choroid, ciliary body**, and **iris**. The choroid has primarily nutritive functions. The ciliary body generates the aqueous humor of the eye, but the ciliary muscle also functions in the optic apparatus. The iris is part of the optic apparatus in which it functions a contractile diaphragm, i.e. the aperture of the eye.
3. An inner sensory layer(neural tunic):This layer consists of the **retina**. The retina proper forms the photoreceptive layer of the eye. As a double-layered epithelium, the retina also covers the ciliary process and the posterior surface of the iris, where it has both nutritive and structural functions.

The internal structure of the eye contains cells that are very important for the eye functions.

**THE FIBROUS LAYER: SCLERA AND CORNEA**

* **SCLERA:** The sclera is commonly referred to as the “whites” of the eye. This is a smooth, white layer on the outside, but the inside is brown and contains grooves that help the tendons of the eye attach properly. The sclera provides structure and safety for the inner workings of the eye, but is also flexible so that the eye can move to seek out objects as necessary. It is a dense connective tissue made of mainly type 1 collagen fibers, oriented in different directions. The lack of parallel orientation of collagen fibers gives the sclera its white appearance, as opposed to the transparent nature of the cornea. However, the collagen of the sclera and cornea are continuous.
* **CORNEA:** The cornea is the outer transparent covering of the eye. This dome-shaped layer protects the eye from elements that could cause damage to the inner parts of the eye. The cornea allows the eye to properly focus on light more effectively. The cornea consists of type I collagen fibers oriented in a uniform parallel direction to maintain transparency. There are several layers of the cornea, creating a tough layer that provides additional protection. These layers regenerate very quickly, helping the eye to eliminate damage more easily. The layers include:

1. Corneal epithelium**:** A non-keratinized, stratified squamous epithelium. It is a fast growing, regenerating multicellular layer which interacts directly with the tear film.
2. Bowman layer: This is a layer of subepithelial basement membrane protecting the underlying stroma. It is composed of type 1 collagen, laminin, and several other heparan sulfate proteoglycans.
3. Stroma (also called substantia propria): This is the largest layer of the cornea, the stroma has collagen fibers arranged in a regular pattern. Keratocytes maintain the integrity of this layer. The function of this layer is to maintain transparency, which occurs by the regular arrangement, and lattice structure of the fibrils, whereby scatter from individual fibrils gets canceled by destructive interference, and the spacing of less than 200 nm allows for transparency.
4. Descemet’s membrane: This is an acellular layer made of type IV collagen that serves as a modified basement membrane of the corneal endothelium.
5. Corneal endothelium: This is a one cell thick layer made of simple squamous or cuboidal cells. Cells in this region do not regenerate and have pumps that maintain fluid balance and prevent swelling of the stroma. When corneal endothelial cells are lost, neighboring cells stretch to attempt to compensate these losses.

**THE VASCULAR LAYER: CHOROID, CILIARY BODY AND IRIS**

* **CHOROID**: The choroid consists of loose connective tissue, which houses a dense network of blood vessels. Connective tissue cells and melanocytes are numerous. The melanocytes give the choroid its dark colour. Small blood vessels are especially frequent in the innermost part of the choroid, which is called the choriocapillary layer. This layer supplies the retina with nutrients. Bruch's membrane is located between the choroid and the retina. It consists of two layers of collagen fibres and a network of elastic fibres between them.
* **CILIARY BODY**: The ciliary body is an inward extension of the choroidea at the level of the lens. Ciliary processes are short extensions of the ciliary body towards the lens. A small amount of loose connective tissue similar to that of the choroid is located between smooth muscle cells which form the bulk of the ciliary body. They form three bundles, the ciliary muscle. The inner surface of the ciliary body and its processes are lined by two layers of columnar cells which belong to the retina - the ciliary epithelium formed by the pars ciliaris of the retina. The outer cell layer is pigmented, whereas the inner cell layer, i.e. the layer that faces the posterior chamber of the eye, is non-pigmented.

The ciliary processes contain a dense network of capillaries. The cells of the inner layer of the ciliary epithelium generate the aqueous humor of the eye. , i.e. they transport the plasma filtrate generated by the capillaries in the ciliary processes into the posterior chamber of the eye. Tight junctions between the cells form the blood - aqueous humor barrier. Fibers, which consist of fibrillin, extend from the ciliary processes towards the lens and form the suspensory ligament of the lens.

These fibres are also called zonule fibres. Two of the bundles of the ciliary muscles attach to the sclera and strech the ciliary body when they contract, thereby regulating the tension of the zonule fibres. The reduced tension will result in a thickening of the lens which focusses the lens on close objects - a process called accommodation.

* **IRIS:** The posterior surface of the iris is covered by the retina. The inner layer of the retina, i.e. the layer facing the posterior chamber, is called the posterior epithelium of the iris. Both layers of the retina are pigmented, but pigmentation is heavier in the inner layer. In the region of the central opening of the iris, the pupil, the retina extends for a very short distance onto the anterior surface of the iris. The iridial stroma consists of a vascularized loose connective tissue rich in melanocytes in addition to macrophages and fibrocytes, which are all surrounded by a loose meshwork of fine collagen fibers. The anterior surface of the iris is not covered by an epithelium - a condensation of fibrocytes and melanocytes, the anterior border layer of the iris.

The iris forms the aperture of the eye. Myoepithelial cells in the outer (or anterior) layer of the retina, i.e. the layer adjacent to the stroma of the iris, have radially oriented muscular extensions. These extensions form a flat sheet immediately beneath the anterior layer of the retina, the dilator pupillae muscle. Embedded in the central portion of the iridial stroma are smooth muscle cells which form the annular sphincter pupillae muscle. In humans, this muscle surrounds the pupil as a less than 1 mm wide and only 0.2 mm thick band. The two muscles regulate the size of the pupil.  
Pupillary constriction, which is mediated by the sphincter pupillae muscle, is clinically refered to as miosis - dilation, mediated by the dilator pupillae muscle, as mydriasis.

The pigmentation of cells in the stroma and anterior border layer of the iris determines to color of the eyes. If cells are heavily pigmented the eyes appear brown. If pigmentation is low the eyes appear blue. Intermediate levels create shades of green and grey.

**THE SENSORY LAYER: RETINA**

* **RETINA:** Similar to the retinal lining of the iris and ciliary body, the outer layer of the light sensitive retina forms a single layer of cuboidal cells - the pigment epithelium. The inner layer of the retina contains the photoreceptors, the first neurons which process the sensory information, and the neurons which convey the pre-processed sensory information to the central nervous system. Receptors, neurons, supporting cells and their processes are segregated into ten layers: The pigmented layer, photoreceptor cell layer, outer limiting layer, outer nuclear layer, outer plexiform layer, inner nuclear, inner plexiform layer, ganglionic layer, nerve fiber layer and inner limiting layer.

2.

Information penetration through the retina goes through these layers:

## 1. The pigmented layer

This layer contains the retinal pigmented epithelium (commonly abbreviated RPE). It is involved in photoreceptor metabolism and that it comprises which captures light not picked up by the photoreceptors. It consists of cuboidal or low columnar cells with basal nuclei and surrounds the neural layer of the retina. The cells have well-developed junctional complexes, gap junctions, and numerous invaginations of the basal membrane associated with mitochondria.

This pigmented layer absorbs scattered light through the neural layer, supplementing the choroid in this regard. The cells of the pigmented epithelium also remove free radicals by various protective antioxidant activities and support the neural retina by secretion of ATP, various polypeptide growth factors, and immunomodulatory factors.

## 2. The photoreceptor cell layer of rods and cones

This layer of rods and cones contains the outer, rod- or cone-shaped light sensitive segments of the photoreceptive cells. It is involved in light capture and PHOTOTRANSDUCTION; the phototransduction cascade occurs here, which transforms light into neural signal. The photoreceptor cell segments are metabolically dependent upon the pigmented epithelium for photoreceptor regeneration and waste disposal. The lights sensitive part and the perikaryon of the rods and cones are connected by a narrowed bridge of cytoplasm. At the level of this connection the rods and cones are surrounded by the processes of a specialized type of glial cells, Müller cells.

**3. Outer limiting membrane**

This layer is a faint but well defined series of gap junctions that form at the level of the rod and cone inner segments between the photoreceptors and the Müller cell processes. This layer forms of the compartment that encloses the rods and cones.

## 4. Outer nuclear layer

This layer contains photoreceptor cell bodies and nuclei of the rod and cone cells. Their processes form part of the outer plexiform layer. Cones have a large outer, conical segment; they provide high-resolution color vision. Rods have a small, narrow cylindrical outer segment; they provide low-resolution dim-light ("night") vision. Rods outnumber cones by roughly 15:1. Cones predominate in central vision (within the fovea), whereas rods predominate in peripheral vision (outside of the macula).

## 5. Outer plexiform layer

This layer includes axons of the photoreceptors and dendrites of association neurons in the inner nuclear layer. It comprises a thin synaptic zone, where synapse between the processes from the outer nuclear layer and processes of neurons whose cell bodies are in the inner nuclear layer is formed.

## 6. Inner nuclear layer

## It contains nuclei of various neurons, notably the bipolar cells, amacrine cells, and horizontal cells, all which are specific connections with other neurons and integrate signals from rods and cones over a wide are of the retina. The inner nuclear layer also houses the perikarya of the Müller cells, whose proximal endings form the inner limiting membrane and distal processes help form the external limiting membrane.

## 7. Inner plexiform layer

This layer consists of axons and dendrites connecting neurons of the inner nuclear layer with the ganglion cells. It comprises a thick synaptic zone and the neurons convey sensory input to the ganglion layer.

## 8. Ganglion cell layer

## It comprises ganglion cell bodies with much longer axons. These axons make up for the nerve fiber layer and converge to form the optic nerve which leaves the eye and passes to the brain while the ganglion cell dendrites help form the inner plexiform layer. The ganglion cells are not evenly distributed. Near the central and macular region of the retina, the ganglionic layer is thickest, but it thins peripherally to only one layer of cells.

## 9. Nerve fiber layer

It comprises axons of the ganglion cells, which are unmyelinated. The axons of the ganglion cells travel in this layer towards the optic disc. Towards the optic disc, the thickness of this layer increases as more and more axons are added to it.

## 10. Inner limiting membrane

It forms from the basal lamina of Müller glial cells.